CHAPTER 8

APPURTENANCES

8.1 Introduction

This chapter discusses several types of equipment used in onsite wastewater treatment/disposal systems that have general application to the components previously presented. The following items are covered:

1. Grease traps (or grease interceptors)
2. Dosing chambers
3. Flow diversion methods

Grease traps are used to remove excessive amounts of grease that may interfere with subsequent treatment. Dosing chambers are necessary when raw or partially treated wastewater must be lifted or dosed in large periodic volumes. Flow diversion valves are used when alternating use of treatment or disposal components is employed. These components are described as to applicability, performance, design criteria, construction features, and operation and maintenance.

8.2 Grease Traps

8.2.1 Description

In some instances, the accumulation of grease can be a problem. In certain commercial/institutional applications, grease can clog sewer lines and inlet and outlet structures in septic tanks, resulting in restricted flows and poor septic tank performance. The purpose of a grease trap is simply to remove grease from the wastewater stream prior to treatment.

Grease traps are small flotation chambers where grease floats to the water surface and is retained while the clearer water underneath is discharged, There are no moving mechanical parts, and the design is similar to that of a septic tank.

The grease traps discussed here are the large., outdoor-type units, and should not to be confused with the small grease traps found on some kitchen drains.

8.2.2 Application

Grease traps are very rarely used for individual homes. Their main application is in treating kitchen wastewaters from motels, cafeterias, restaurants, hospitals, schools, and other institutions with large volumes of kitchen wastewaters.

Influents to grease traps usually contain high organic loads including grease, oils, fats, and dissolved food particles, as well as detergents and suspended solids. Sanitary wastewaters are not usually treated by grease traps. Wastewaters from garbage grinders should not be discharged to grease traps, as the high solids loadings can upset grease trap performance and greatly increase both solids accumulations and the need for frequent pumpout.

8.2.3 Factors Affecting Performance

Several factors can affect the performance of a grease trap: wastewater temperature, solids concentrations, inlet conditions, retention time, and maintenance practices.

By placing the grease trap close to the source of the wastewater (usually the kitchen) where the wastewater is still hot, grease separation and skimming (if used) are facilitated. As previously mentioned, high solids concentrations can impair grease flotation and cause a solids buildup on the bottom, which necessitates frequent pumpout. Flow control fittings should be installed on the inlet side of smaller traps to protect against overloading or sudden surges from the sink or other fixtures. These surges can cause agitation in the trap, impede grease flotation, and allow grease to escape through the outlet. Hydraulic loading and retention time can also affect performance. High loadings and short retention times may not allow sufficient time for grease to separate fully, resulting in poor removals. Maintenance practices are important, as failure to properly clean the trap and remove grease and solids can result in excessive grease buildup that can lead to the discharge of grease in the effluent.

8.2.4 Design

Sizing of grease traps is based on wastewater flow and can be calculated from the number and kind of sinks and fixtures discharging to the trap. In addition, a grease trap should be rated on its grease retention capacity, which is the amount of grease (in pounds) that the trap can hold before its average efficiency drops below 90%. Current practice is that grease-retention capacity in pounds should equal at least twice the flow capacity in gallons per minute. In other words, a trap rated at 20 gpm (1.3 l/sec) should retain at least 90% of the grease discharged to it until it holds at least 40 lb (18 kg) of grease (1). Most manufacturers of commercial traps rate their products in accordance with this procedure.

Recommended minimum flow-rate capacities of traps connected to different types of fixtures are given in Table 8-1.

Another design method has been developed through years of field experience (3). The following two equations are used for restaurants and other types of commercial kitchens:

1. RESTAURANTS:

$$(D) \times (GL) \times (ST) \times \left(\frac{HR}{2}\right) \times (LF) = \text{Size of Grease Interceptor, gallons}^{a}$$

GL = Gallons of wastewater per meal, normally 5 gal
ST = Storage capacity factor -- minimum of 1.7
onsite disposal - 2.5
HR = Number of hours open
LF = Loading factor -- 1.25 interstate freeways
1.0 other freeways
1.0 recreational areas
0.8 main highways
0.5 other highways

2. HOSPITALS, NURSING HOMES, OTHER TYPE COMMERCIAL KITCHENS WITH VARIED SEATING CAPACITY:

$$(M) \times (GL) \times (ST) \times (2.5) \times (LF) = \text{Size of Grease Interceptor, gallons}^{a}$$

where:

M = Meals per day
GL = Gallons of wastewater per meal, normally 4.5

TABLE 8-1

RECOMMENDED RATINGS FOR COMMERCIAL GREASE TRAPS (1)

Type of Fixture	Flow Rate gpm	Grease Retention Capacity Rating lb	Recommended Maximum Capacity Per Fixture Connected to Trap gal
Restaurant kitchen sink	15	30	50.0
Single-compartment scullery sink	20	40	50.0
Double-compartment scullery sink	25	50	62.5
2 single-compartment sinks	25	50	62.5
2 double-compartment sinks	35	70	87.5
Dishwashers for restaurants:			
Up to 30 gal water capacity	15	30	50.0
Up to 50 gal water capacity	25	50	62.5
50 to 100 gal water capacity	40	80	100.0

SC = Storage capacity factor -- minimum of 1.7
onsite disposal - 2.5

LF = Loading factor -- 1.25 garbage disposal & dishwashing
1.0 without garbage disposal
0.75 without dishwashing
0.5 without dishwashing and garbage disposal

[a] Minimum size grease interceptor should be 750 gal

Thus, for a restaurant with a 75-seat dining area, an 8 hr per day operation, a typical discharge of 5 gal (19 l) per meal, a storage capacity factor of 1.7 and a loading factor of 0.8, the size of the grease interceptor is calculated as follows:

$$(75) \times (5) \times (1.7) \times \left(\frac{8}{2}\right) \times (0.8) = 2{,}040 \text{ gal } (7{,}722 \text{ l})$$

Other design considerations include: facilities for insuring that both the inlet and outlet are properly baffled; easy manhole access for cleaning; and inaccessibility of the trap to insects and vermin.

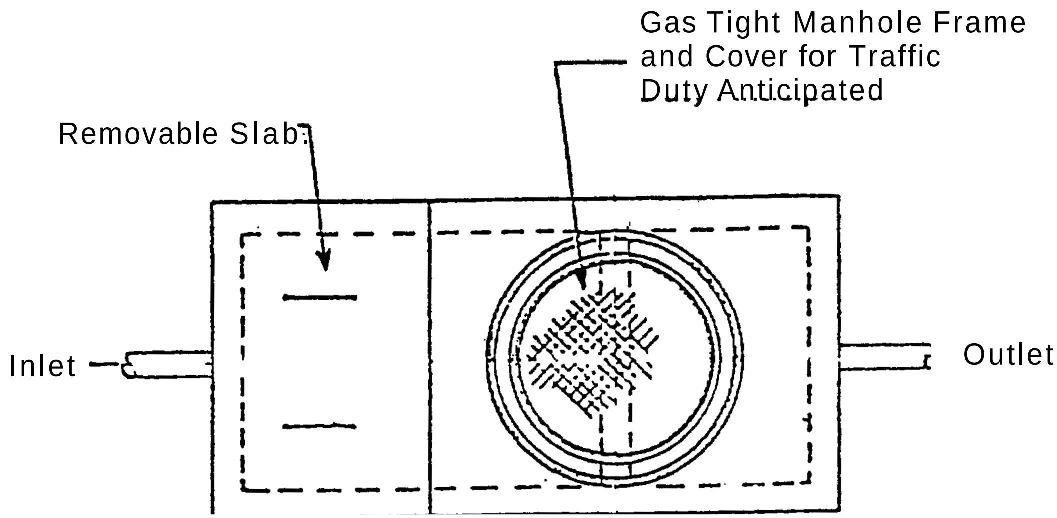
8.2.5 Construction Features

Grease traps are generally made of pre-cast concrete, and are purchased completely assembled. However, very large units may be field constructed. Grease traps come in single- and double-compartment versions. Figure 8-1 shows a typical pre-cast double-compartment trap (2).

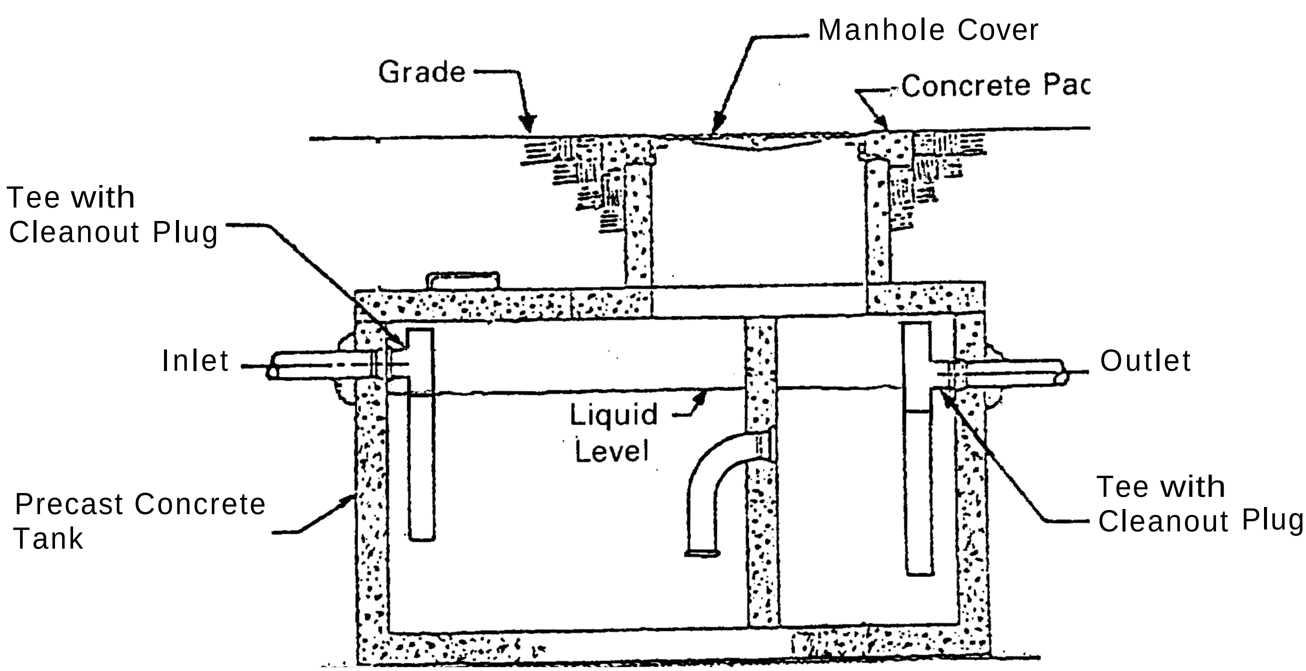
Grease traps are usually buried so as to intercept the building sewer. They must be level, located where they are easily accessible for cleaning, and close to the wastewater source. Where efficient removal of grease is very important, an improved two-chamber trap has been used which has a primary (or grease-separating) chamber and a secondary (or grease-storage) chamber. By placing the trap as close as possible to the source of wastewaters, where the wastewaters are still hot, the separating grease at the surface of the first chamber can be removed by means of an adjustable weir and conveyed to the separate secondary chamber, where it accumulates, cools, and solidifies. This decreases the requirement for cleaning and allows better grease separation in the first chamber.

FIGURE 8-1

DOUBLE-COMPARTMENT GREASE TRAP



Top View



Section

The inlet, outlet, and baffle fittings are typically of "T" design with a vertical extension 12 in. (30 cm) from the tank floor and reaching well above the water line (3).

To allow for proper maintenance, manholes to finished grade should be provided. The manhole covers should be of gas-tight construction and should be designed to withstand expected loads.

A check of local ordinances and codes should always be made before the grease trap is designed or purchased.

8.2.6 Operation and Maintenance

In order to be effective, grease traps must be operated properly and cleaned regularly to prevent the escape of appreciable quantities of grease. The frequency of cleaning at any given installation can best be determined by experience based on observation. Generally, cleaning should be done when 75% of the grease-retention capacity has been reached. At restaurants, pumping frequencies range from once a week to once every 2 or 3 months.

8.3 Dosing Chambers

8.3.1 Description

Dosing chambers are tanks that store raw or pretreated wastewater for periodic discharge to subsequent treatment units or disposal areas. Pumps or siphons with appropriate switches and alarms are mounted in the tank to discharge the accumulated liquid.

8.3.2 Application

Dosing chambers are used where it is necessary to elevate the wastewater for further treatment or disposal, where intermittent dosing of treatment units (such as sand filters) or subsurface disposal fields is desired, or where pressure distribution networks are used in subsurface disposal fields. If the dosing chamber is at a lower elevation than the discharge point, pumps must be used. If the dosing chamber is at a higher elevation, siphons may be used, but only if the settleable and floatable solids have been removed from the wastewater stream.

8.3.3 Factors Affecting Performance

Factors that must be considered in design of dosing chambers are (1) the dose volume, (2) the total dynamic head, (3) the desired flow rate, and (4) the wastewater characteristics. When pumps are used, they must be selected based on all three factors. If raw wastewater with large solids is pumped, grinder pumps or pneumatic ejectors must be used. Siphons are chosen on the basis of the desired flow rate and their discharge invert elevations determined from the total dynamic head. Only wastewaters free from settleable and flotable solids can be discharged by siphons. If corrosive wastewaters such as septic tank effluent are being discharged, all equipment must be selected to withstand the corrosive atmosphere.

8.3.4 Design

8.3.4.1 Dosing Chambers with Pumps

A pumping chamber consists of a tank, pump, pump controls, and alarm system. Figure 8-2 shows a cross section of a typical pumping chamber used for pumping pretreated wastewater. The tank can be a separate unit as shown, or it can have common wall construction with the pretreatment unit.

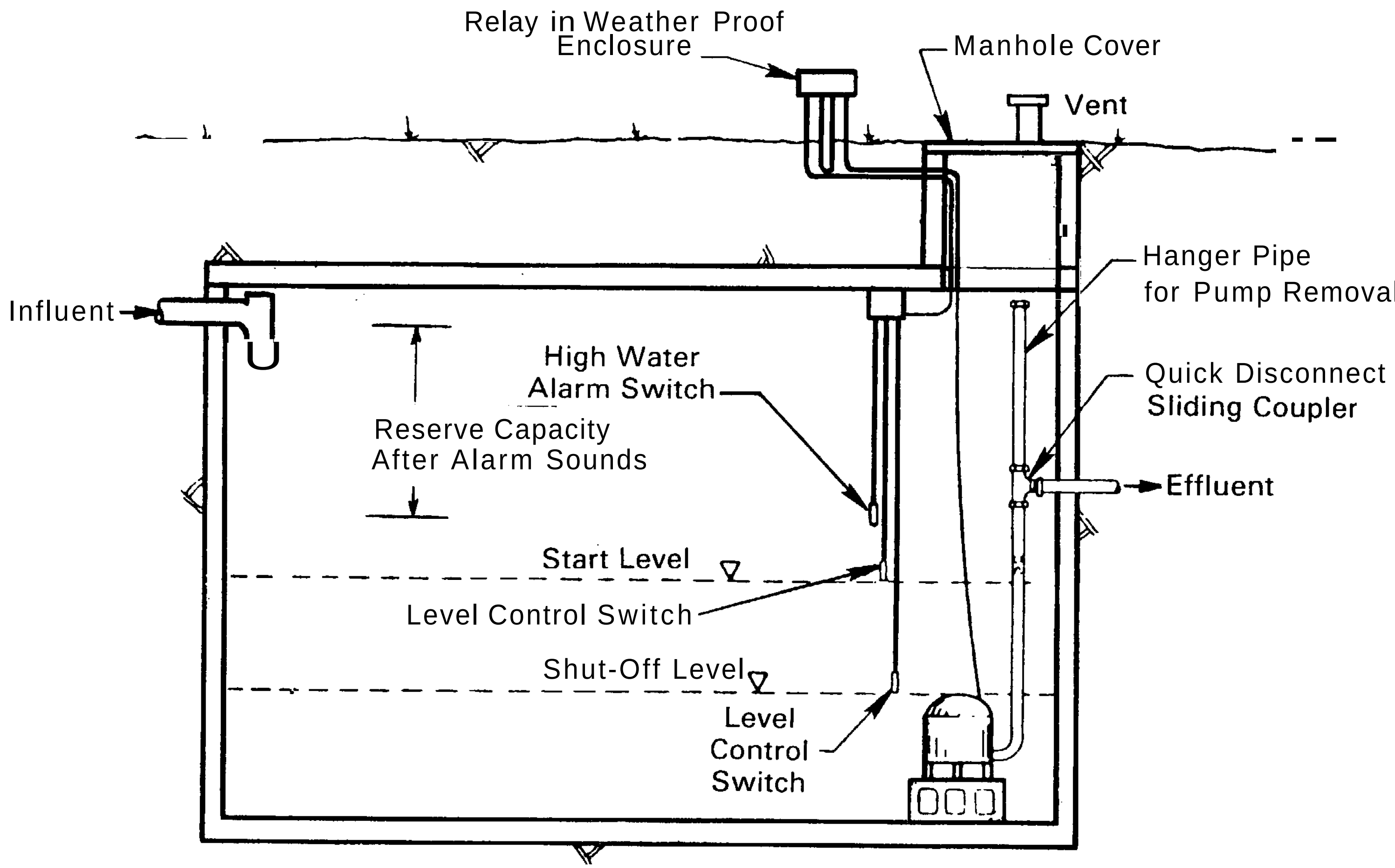
The tank should have sufficient volume to provide the desired dosing volume, plus a reserve volume. The reserve volume is the volume of the tank between the high water alarm switch and the invert of the inlet pipe. It provides storage during power outages or pump failure. A reserve capacity equal to the estimated daily wastewater flow is typically used for residential application (4). In large flow applications, duplex pump units can be used as an alternative to provide reserve capacity. No reserve capacity is necessary when siphons are used.

Pump selection is based on the wastewater characteristics, the desired discharge rate, and the pumping head. Raw wastewater requires a pump with solids-handling capabilities. Grinder pumps, pneumatic ejectors, or solids-handling centrifugal pumps are suitable for these applications. While pneumatic ejectors may be used in other applications as well, submersible centrifugal pumps are best suited where large volumes are to be pumped in each dose.

The pump size is determined from pump performance curves provided by the manufacturers. Selection is based on the flow rate needed and the pumping head. The specific application determines the flow rate needed.

FIGURE 8-2

TYPICAL DOSING CHAMBER WITH PUMP



The pumping head is calculated by adding the elevation difference between the discharge outlet and the average or low water level in the dosing chamber to the friction losses incurred in the discharge pipe. The velocity head can be neglected in most applications.

If the liquid pumped is to be free from suspended solids, the pump may be set on a pedestal. This provides a quiescent zone below the pump where any solids entering the chamber can settle, thus avoiding pump damage or malfunction. These solids must be removed periodically.

In cold climates where the discharge pipe is not buried below the frost line, the pipe should be drained between doses. This may be done by sloping the discharge pipe back to the dosing chamber and eliminating the check valve at the pump. In this manner, the pipe is able to drain back into the dosing chamber through the pump. The dosing volume is sized to account for this backflow. Weep holes may also be used if the check valve is left in place.

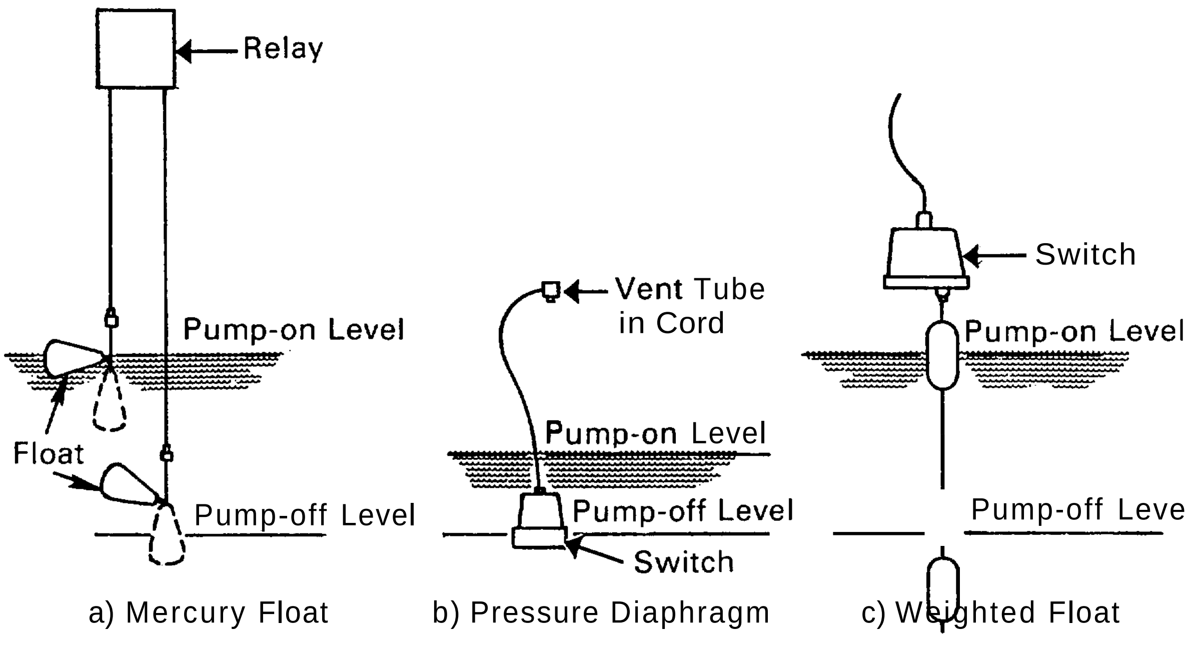
The control system for the pumping chamber consists of a "pump off" switch, a "pump on" switch, and a high water alarm switch. The pump off switch is set several inches above the pump intake. The pump on switch is set above the pump off switch to provide the proper dosing volume. Several inches above the pump on switch, a high water alarm switch is set to alert the owner of a pump malfunction by activating a visual and/or audible alarm. This switch must be on a circuit separate from the pump switches.

The switches should withstand the humid and other corrosive atmosphere inside the tank. Pump failures can usually be traced to switch failures resulting in pump burn out, so high quality switches are a good investment. Some types are:

1. Mercury: Two basic types are available. One is an on-off switch sealed within a polyethylene float suspended from the top of the chamber by its power cord. Two switches are necessary to operate the pump (See Figure 8-3). The elevations are adjusted individually. Differential switches are also available to turn the pump on and off with one switch, but these lack the ability to adjust the dosing volume.

FIGURE 8-3

LEVEL CONTROL SWITCHES



2. Pressure Diaphragm: The pressure diaphragm switch is a micro-switch mounted behind a neoprene diaphragm. The microswitch side of the diaphragm is vented to the atmosphere by means of a vent tube imbedded in the power cord. The other side is sub-merged in the liquid. As the liquid level rises and falls, the pressure on the diaphragm activates the switch (See Figure 8-3). Thus, one switch is sufficient to operate the pump; but the differential in liquid levels is usually limited to about 6 in, although switches with larger differentials can be pur-chased. If used in pumping chambers, the vent tube must be located outside the pumping chamber or the humid atmosphere in the chamber can cause the switch to corrode.

3. Weighted Float: The switch is mounted above the water with 2 weights attached to a single cable hanging from the switch (See Figure 8-3). When the weights are hanging free, the switch is held open; but as the liquid level rises, the weights are buoyed up, closing the switch when the second weight is sub-merged. The switch is held closed by a magnet; but as the

liquid level drops, the weights lose their buoyancy and open the switch when the bottom weight is exposed. The dosing volume can be changed by adjusting the spacing between the floats.

All electrical contacts and relays must be mounted outside the chamber to protect them from corrosion. Provisions should be made to prevent the gases from following the electrical conduits into the control box.

8.3.4.2 Dosing Chambers with Siphons

Siphons may be used in place of pumps if the point of discharge is at a lower elevation than the outlet of the pretreatment unit. A chamber employing siphons consists of only a tank and the siphon. No mechanical or electrical controls are necessary, since the siphon operation is automatic. A typical siphon chamber is illustrated in Figure 8-4. Two siphons may be placed in a tank and automatically alternate, providing a simple method of dividing the wastewater flow between two treatment or disposal units.

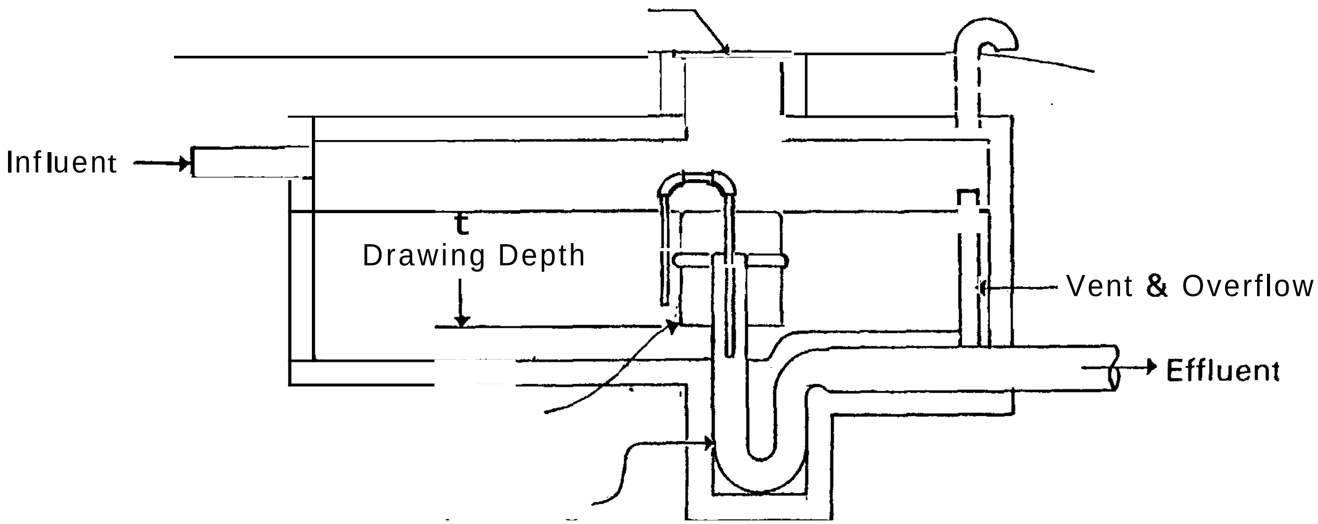
The design of the dosing chamber is determined by the siphon selected and the head against which it must operate. The size of the siphon is determined by the average flow rate desired. The manufacturer specifies the "drawing depth," or the depth from the bottom of the siphon bell to the high water level necessary to activate the siphon (See Figure 8-4). The length and width of the chamber are determined by the dosing volume desired.

Siphon capacity is rated when discharging into the open atmosphere. Therefore, if the discharge is into a long pipe or pressure distribution network, the headlosses must be calculated and the invert at the siphon discharge set at that distance above the outlet. For high discharge rates or where the discharge pipe is very long, the discharge pipe should be one nomimal pipe size larger than the siphon to facilitate air venting.

The siphons may be cast iron or fiberglass. Cast iron siphons are the most common. Their advantage is that the bell is merely set on the discharge pipe so they may be easily removed and inspected. They are subject to corrosion, however. Fiberglass siphons do not corrode, but because of their light weight, they must be bolted to the chamber floor.

FIGURE 8-4

TYPICAL DOSING CHAMBER WITH SIPHON



8.3.5 Construction

The tank must be watertight so groundwater does not infiltrate it. Waterproofing consists of adequately sealing all joints with asphalt or other suitable material. Coating the outside *of* the tank prevents groundwater from seeping into the tank. Asphalt coating the inside and outside of steel tanks helps retard corrosion. Application of 4-mil plastic to the wet asphalt coating protects the coating when back-filling.

At high water table sites, precautions should be taken so the chamber does not float out of position due to hydrostatic pressures on a near-empty tank. This is not normally a problem for concrete tanks, but for the lighter-weight materials, such as fiberglass, it could present a problem. The manhole riser pipe should be a minimum of 24 in. (61 cm) in diameter and should extend 6 in. (15 cm) above ground level to keep surface 'water from entering the chamber.

If plastic pipe is used for the inlet or discharge, precaution should be taken to ensure that the pipe does not break as the backfilled soil around the tank settles. A cast iron pipe sleeve or other suitable device can be slipped over the plastic pipe extending from the tank to unexcavated soil to provide this protection.

8.3.6 Operation and Maintenance

Little routine maintenance of dosing chambers is required. The tank should be inspected periodically, and any solids that accumulate on the floor of the tank should be removed. If pumps are used, the system should be cycled to observe operation of the switches and pump. If siphons are used, the water level in the tank should be noted over a period of time to determine if the siphon is operating properly. If the siphon is working properly, the water level will fluctuate from the bot-*tom* 1ip of the siphon bell to several inches above the bell. If the water elevation does not change despite water addition, the siphon is "dribbling," indicating that the vent tube on the bell requires cleaning.

8.4 Flow Diversion Methods for Alternating Beds

8.4.1 Description

Under some circumstances, it is desirable to divert the wastewater flow from one soil absorption area to another to provide long-term alternate resting periods (see Chapter 7). Flow diversion may be accomplished by the use of commercially available diversion valves (Figure 8-5) or by diversion boxes (Figures 8-6 and 8-7).

FIGURE 8-5

TYPICAL DIVERSION VALVE

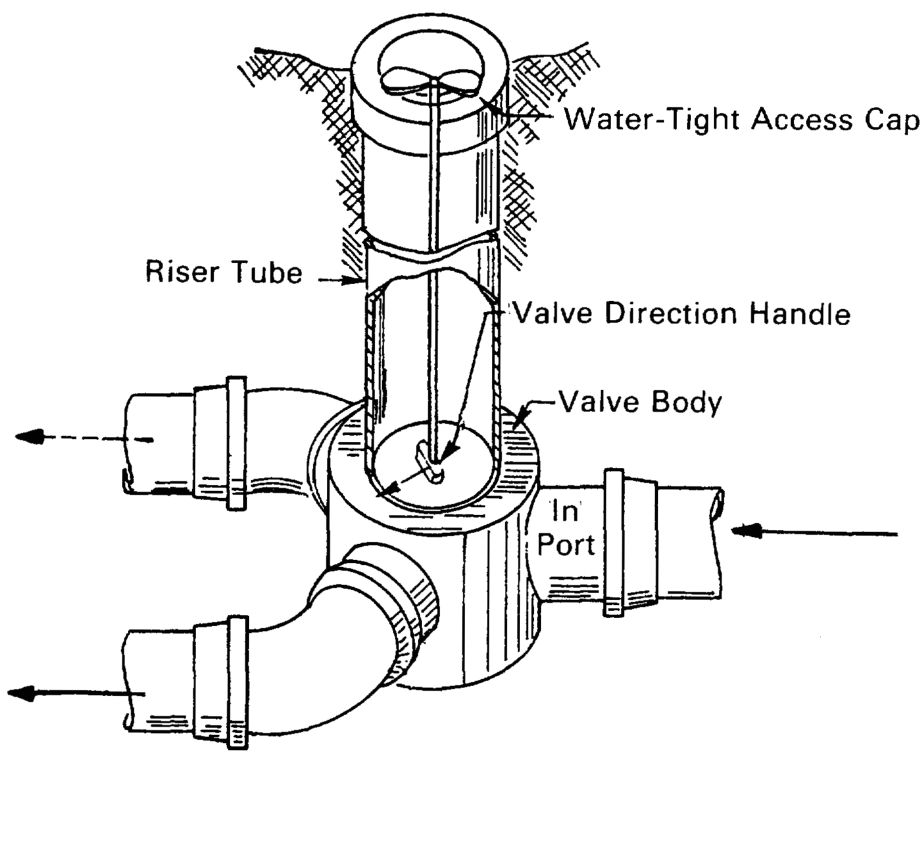


FIGURE 8-6

TOP VIEW OF DIVERSION BOX UTILIZING A TREATED WOOD GATE

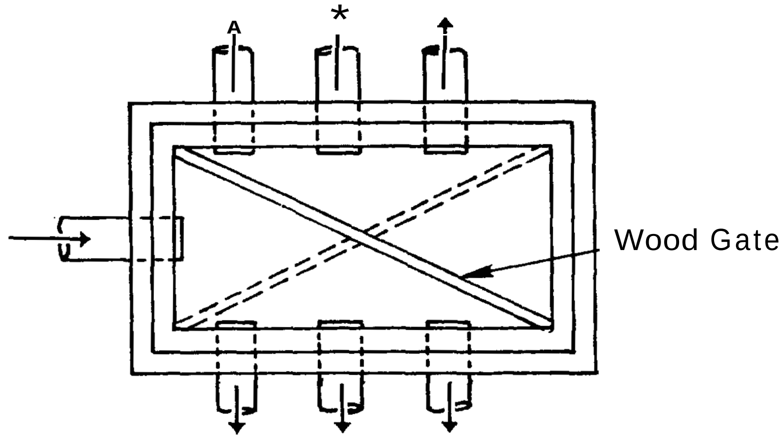
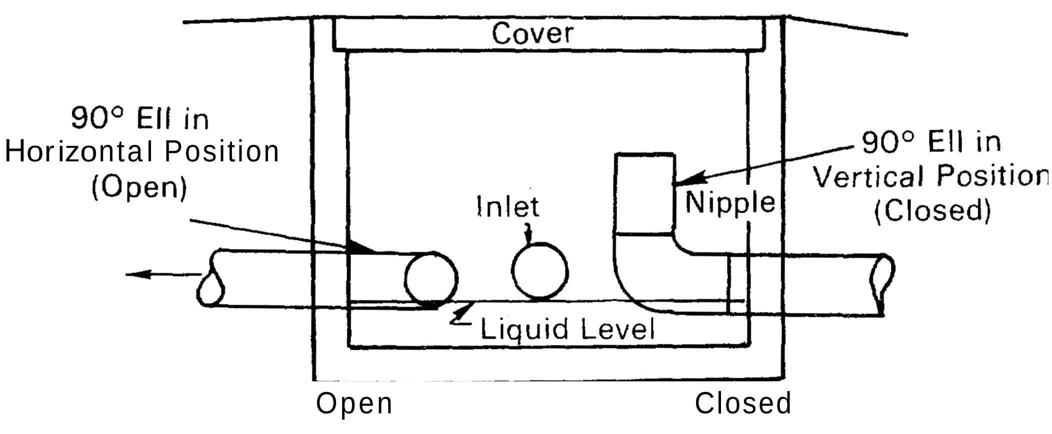


FIGURE 8-7

SECTION VIEW OF DIVERSION BOX UTILIZING ADJUSTABLE ELLS



8.4.2 Design

Diversion boxes can be made from conventional distribution boxes. One type of diversion box shown in Figure 8-6 uses a treated wood gate to divert the flow to the desired outlet pipe (5).

Another, shown in Figure 8-7, uses 90^{o} ells that can be moved from the horizontal to the vertical position to shut off flow. Caps or plugs can be used in place of elbows. Elbows, however, provide a freer flow of air into the resting system. Insulated covers must be provided with diversion boxes when installed in cold climates.

8.4.3 Construction

Construction follows manufacturers recommendations or the procedures outlined for distribution boxes (Chapter 7).

8.4.4 Maintenance

Maintenance of diversion valves involves little more than turning the valve at the desired frequency. Any accumulated solids in the diversion box or valve should be removed periodically.

8.5 References

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